U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF MICROSCOPY.

FOOD PRODUCTS.—III.

I. IMPROVED METHODS OF DISTINGUISHING BETWEEN PURE AND FICTITIOUS LARD.

II. FOUR EDIBLE MUSHROOMS OF THE UNITED STATES.

BY

THOMAS TAYLOR, M. D.,

CHIEF OF THE DIVISION OF MICROSCOPY.

REPRINTED, WITH REVISION, FROM THE REPORT OF THE SECRETARY OF AGRICULTURE FOR 1891.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1893.

U. S. DEPARTMENT OF AGRICULTURE.
DIVISION OF MICROSCOPY.

FOOD PRODUCTS.—III.

I. IMPROVED METHODS OF DISTINGUISHING BETWEEN PURE AND FICTITIOUS LARD.

II. FOUR EDIBLE MUSHROOMS OF THE UNITED STATES.

BY

THOMAS TAYLOR, M. D.,
CHIEF OF THE DIVISION OF MICROSCOPY.

REPRINTED, WITH REVISION, FROM THE REPORT OF THE SECRETARY OF AGRICULTURE FOR 1891.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1893.

INTRODUCTORY NOTE.

U. S. Department of Agriculture,
Division of Microscopy,
Washington, D. C., September 22, 1893.

Sir: The accompanying papers from my report for the year 1891 are respectfully submitted, with the request that they be reprinted in order to facilitate compliance with the requests of correspondents.

Very respectfully,

Thomas Taylor,
Microscopist.

Hon. J. Sterling Morton,
Secretary of Agriculture.

CONTENTS.

IMPROVED METHODS OF DISTINGUISHING BETWEEN PURE AND FICTITIOUS LARD.

The following preliminary statement of experiments has been prepared in consideration of the many requests received in this division for information which will enable one skilled in the use of the microscope to distinguish pure lard from fictitious lard:

(1) Heat, over the flame of a Bunsen burner, in a porcelain capsule, 4 ounces of pure home-rendered leaf lard, for a period of one minute, and allow it to cool slowly until it solidifies, which will require a period of about four hours, in an atmosphere of about 75° F. The crystalline groupings of this sample will appear very small when viewed under a power of 100 diameters.

(2) Prepare, in like manner, another sample of pure leaf lard, heating it for a period of four minutes, and allowing it to cool slowly, as above. It will be observed that pure lard in this case shows well-defined crystals of stearin, viewed under the microscope as above, and will, without regard to the high temperatures to which it has been exposed, consolidate in about the time given in the first experiment.

(3) Prepare a sample of compound lard, consisting of commercial stearin and sufficient cotton-seed oil to bring the stearin to the consistency of good pure lard; heat four minutes, and cool slowly. It will consolidate in about an hour, at 75° F.

(4) Prepare a second sample of compound lard, consisting principally of commercial stearin to which a trace of pure lard has been added; heat this compound for a period of four minutes. This compound will also consolidate quickly, owing to the presence of stearin in large quantity.

(5) Prepare a third sample of compound lard, consisting of commercial stearin, oleo, and cotton-seed oil, with a trace of pure lard; heat four minutes, and allow it to cool slowly, at 75° F. In this case it will be observed that the time required for consolidation will depend upon the amount of stearin present.

(6) Prepare a sample of commercial oleo after the method of the first experiment. This, like pure lard, will require about four hours, at 75° F., to consolidate.

(7) Prepare a sample of commercial stearin, heating it four minutes. This will consolidate in about half an hour or less, at the temperature given above.

Some samples of compound lard are very deceptive in appearance, being smooth and translucent, especially such as are composed of lard and oleo, but these are easily detected by the use of the microscope and polarized light. My usual practice is, first, to examine each sample with the unaided eye, compressing a portion of the lard about the size of a large pin head between two pieces of clear glass about 1 inch square each, and holding each sample up to the light to compare it with a sample of home-rendered lard similarly prepared. As fictitious lard contains a large amount of stearin, it will exhibit by this method of examination many white spots, which represent the crystallized stearin, and which are not seen in pure lard. The amount of natural

stearin in pure lard is so small that it is not visible to the unaided eye by this method of examination; therefore the microscope should be used in the examination of pure lard, as the groupings of the crystallized fats of lard are very small. These groupings are in stellar forms, composed of spicules which proceed from a common center, frequently requiring to be magnified 400 times to discern them, while the groupings of branched crystals of stearin are easily observed to advantage under a power of 100 diameters.

Stearin constitutes one of the principal fats of fictitious lard. It gives firmness to the other fats and is less soluble than palmitin. It is the first to crystallize when held in solution with other fats. Its branched groupings are easily resolvable under the microscope, and always appear very bright by polarized light. Taking advantage of these facts, I heat, say, 4 ounces of a suspected lard in any suitable vessel, over the flame of a Bunsen burner. If the sample hardens quickly in a temperature of about 75° F., it will be found to contain a large amount of stearin. A sample, on the other hand, consisting principally of either pure lard or oleo, or of a mixture of these two, will consolidate very slowly as compared with a sample to which a large proportion of commercial stearin has been added. The first fumes which arise in the heating process will indicate somewhat the composition of the fat. If it contains a large amount of leaf or other lard, the lard odor will be easily recognized. If the sample contains only a trace of lard, the lard odor will be evanescent. If very acrid fumes arise during the heating process, producing a tendency to cough on the part of the observer, the presence of cotton-seed oil is indicated.

The two commercial solid fats which enter largely into compound lard, as at present manufactured, are commercial stearin and oleo, to which is generally added cotton-seed oil for the purpose of reducing the stearin to the consistency of pure home-rendered lard.

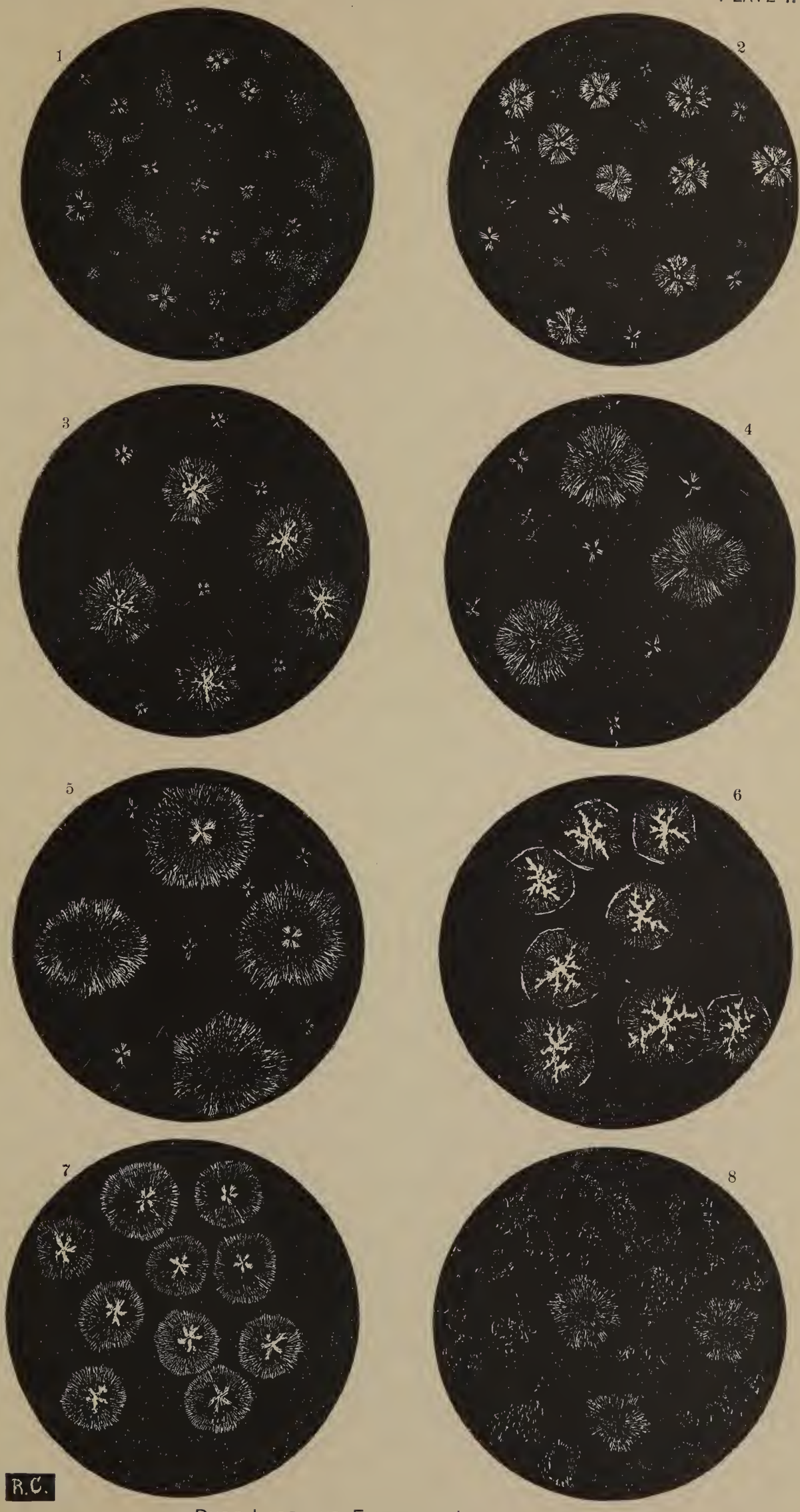
Explanation of Plate I.

Plate 1 represents the various crystalline forms of pure leaf lard, lard compounds, and compound fats sold as lard. Figs. 1, 2, and 8, crystalline forms of pure leaf lard; Fig. 3, a compound of stearin, oleo, and cotton-seed oil; Fig. 4, a compound of lard and oleo; Fig. 5, stearin, oleo, and cotton-seed oil; Fig. 6, stearin, cotton-seed oil, and a trace of palmitin; Fig. 7, stearin, oleo, and cotton-seed oil.

Samples 3, 5, 6, and 7 are varied in their proportions of stearin, oleo, and cotton-seed oil. When stearin is in excess in one of these compounds it appears in very bright, branching crystals in the center of each mass of crystallized palmitin. All fictitious lards abound in stearin. On being highly heated and cooled slowly in a temperature of about 75° the stearin, being less soluble than the palmitin fat, crystallizes first; the palmitin next crystallizes over the branching stearin crystals.

Viewed under polarized light with dark ground, the compositions of the respective fats, stearin and palmitin, are at once distinguished one from the other. The cotton-seed oil, although a fat, is not observed under the microscope, as it does not crystallize at ordinary temperatures.

Pure lard, unless highly heated, exhibits a dull crystalline appearance as compared with stearin, as it consists mostly of palmitin and oil, with but a trace of stearin.



PURE LARD AND FICTITIOUS LARD.

1, 2, and 8, pure lard; 3, 5, and 7, stearin, oleo, and cotton-seed oil; 4, lard and oleo; 6, stearin.

FOUR EDIBLE MUSHROOMS OF THE UNITED STATES.

In the present paper, as well as in my former papers relating to poisonous and edible mushrooms, I have endeavored in my descriptions of species to employ terms which are in common use in all English-speaking countries, giving at the same time their scientific equivalents. As this method is not always a convenient one, and as the need of a glossary of terms relating to fungi has been urged frequently by students of the subject, such a glossary has been appended to this paper. To facilitate the study of the structural forms of the mushroom group, moreover, a plate is inserted, which consists of sectional drawings showing the diverse forms of the mushroom cap, the gills, and the stalk. The requests of many correspondents leave no room to doubt that both glossary and plate will be appreciated. The colored illustrations will also be found helpful, it is believed, in enabling those who are not possessed of botanical skill to distinguish species.

THE CULTIVATION OF MUSHROOMS.

The successful cultivation of mushrooms on a large scale is carried on in many places throughout Europe and especially in Great Britain. Mr. John F. Barter, of London, England, who is considered the largest mushroom-grower in Great Britain, wrote to a friend in the United States that he marketed during the season of 1889–'90 11 tons of mushrooms, and during the season of 1890–'91 about 10 tons. In a meritorious treatise on Mushroom Culture for Pleasure and Profit, by Mr. William Falconer, of New Jersey, the author remarks:

> In the most prosperous and progressive of all countries, with a population of nearly 70,000,000 of people alert to every profitable legitimate business, mushroom-growing, one of the simplest and most remunerative of industries, is almost unknown. Mushrooms and their extensive and profitable culture should concern every one.
>
> For home consumption they are a healthful and grateful food, and when successfully grown for market they become a most profitable crop. No one can grow mushrooms better nor more economically than the farmer. He has already the cellar room, the fresh manure, and the loam, and all he needs is some spawn with which to plant the beds. Nothing is lost. The manure after having been used in mushroom beds is not exhausted of its fertility, but instead is well rotted and in a better condition to apply to the land than it was before being used for the mushroom crop. The farmer will not feel the little labor it takes. There is no secret whatever connected with it, and skilled labor is unnecessary to make it successful. The commonest farm hand can do the work, which consists of turning the manure once every day or two, for about three weeks, and then building it into a bed and spawning

and covering it with mold. Nearly all the labor for the next ten or twelve weeks consists in maintaining an even temperature and gathering and marketing the crop.

Many women are searching for remunerative and pleasant employment on the farm, and what can be more interesting, pleasant, and profitable work for them than mushroom-growing? After the farmer makes up the mushroom bed, his wife or daughter can attend to its management with scarcely any tax upon her time and without interfering with her other domestic duties. And it is clean work; there is nothing menial about it. No lady in the land would hesitate to pick the mushrooms in the open field; how much less, then, should she hesitate to gather the fresh mushrooms from the clean beds in her own clean cellar. Mushrooms are a winter crop; they come when we need them most. The supply of eggs in the winter season is limited enough and pin money often proportionately short; but with an insatiable market demand for mushrooms all winter long at good prices, no farmer's wife need care whether the hens lay eggs at Christmas or not. When mushroom-growing is intelligently conducted there is more money in it than in hens, and with less trouble.

There are those who venture to assert, as will be seen from the following paragraph from Hardwick's Science Gossip, that the cultivation of mushrooms will eventually have an important bearing upon the world's food supply:

Occasionally we hear vegetarians say they live upon some fabulously small sum—a few pence per diem, and although very few people indeed would care to debar themselves of wholesome, nutritious food for the sake of a mere theory, yet it can not be overlooked that the continued and continuing increase of the population will eventually demand a full development of the resources of the country. There can not be a doubt that the esculent species of fungi will in the future occupy a most important place in the dietary of the nation, not simply because of their cheapness, but rather by reason of their nutritious qualities and the large proportion of nitrogenous compounds they contain.

METHODS OF MUSHROOM CULTURE.

The cellar of a dwelling house is a capital place for mushroom beds, and can be used in whole or in part for this purpose. In the case of private families, who wish to grow only a few mushrooms for their own use, it is not necessary to use the whole cellar; it will be sufficient to partition off a part of it with boards and make the beds in this, or to make a bed alongside of the wall anywhere and box it in to protect it from cold drafts and from mice and rats. Shelves may be placed above the bed for domestic purposes, just as in any other part of the cellar. Bear in mind that mushrooms thrive best in an atmospheric temperature of from 50° to 60° F., and if you can give them this in your house-cellar you ought to get plenty of good mushrooms. But if such a high temperature can not be maintained without impairing the usefulness of the cellar for other purposes, box up the bed tightly, and from the heat of the bed itself when thus confined there usually will be warmth enough for the mushrooms; but if there is not, spread a piece of old carpet or matting over the boxing.

The beds may be made upon the floor, flat or ridged, or banked against the wall, 10 or 12 inches deep in a warm cellar, and 15 to 20 inches or more deep in a cool cellar, and about 3 feet wide and any

length to suit. The boxing may consist of any kind of boards for sides and ends, and may be built about 6 or 10 inches higher than the top of the beds, so as to give the mushrooms plenty of head room. The top of the boxing may be a lid hung on hinges or straps, or otherwise arranged to admit of being easily raised or removed at will, and made of light lumber, say half-inch boards. In this way, by opening the lid, the mushrooms are under observation and can be gathered without any trouble. When the lid is shut they are secure from cold and vermin. Thus protected, the cellars can be ventilated without interfering with the welfare of the mushrooms. A light wooden frame, covered with calico or oiled paper, would also make a good top for the boxing, but would not be proof against much cold or against rats or mice. If desirable, shelf beds could be built in warm cellars above the floor beds, but in cool, airy cellars this would not be advisable. Manure beds in the dwelling-house cellar may seem highly improper to many people, but when rightly handled these beds emit no bad odor. The manure should be prepared away from the house, and when ready for making into beds should be spread out thin, so as to become perfectly cool and free from steam. When it has lain for two days in this condition, it may be brought into the cellar and made into beds. Having been well sweetened by previous preparation, it is now cool, free from steam, and almost odorless. After a few days it will warm up a little, and may then be spawned and earthed over at once. Do not bury the spawn in the manure; merely set it in the surface of the manure. This method prevents the spawn from being destroyed by too great heat should the bed become unduly warm. If the manure has been well prepared, however, this is not likely to occur. The coating of loam prevents the escape of any further steam or odor from the manure.

On the 14th of January last Mr. W. Robinson, editor of the London Garden, in writing to Mr. William Falconer mentioned the following very interesting case of growing mushrooms in the cellar of a dwelling house:

> I went out the other day to see Mr. Horace Cox, the manager of the Field newspaper, who lives at Harrow, near the famous school. His house is heated by a hot-water system called Keith's, and the boiler, which is a very simple one, is in a chamber of the house in the basement. I went down to see it worked with coke refuse. However, I was pleased to see all the floor of the room not occupied by the boiler covered with little flat mushroom-beds and bearing a very good crop. Truth to tell, I used to fear that growing mushrooms in dwelling houses might be objectionable in various ways, but this instance is very interesting, as there is not even the slightest unpleasant smell in the chamber itself. The beds are small, scarcely a foot high, and perfectly odorless, so that it is quite clear that one may cultivate mushrooms in one's house in such a case as this without the slightest offense. A bed has been known to begin bearing early in November and to bear a good crop until the 1st of May.

Mr. Denton, a market gardener, about 10 miles from New York on Long Island, uses both French and brick spawn. He markets from 1,700 to 2,500 pounds of mushrooms a year from his two cellars. Every summer he cleans out his cellars and lime-washes them all over. He ascribes his success to thorough cleaning.

CULTIVATION OF MUSHROOMS ON THE CONTINENT OF EUROPE.

As regards the cultivation of mushrooms on the continent of Europe, I briefly summarize from a late Italian author various methods for the benefit of our readers.

A way at once easy and simple of raising mushrooms perennially is to dig a trench 2 feet wide by 6 inches deep and of length proportionate to the extent of ground, in a well sheltered garden having a southern or eastern exposure. Fill this trench with good horse manure that is larded with mushroom spawn, and cover with rich earth. Water the bed from time to time, frequently in summer, especially if a very hot season, and protect the bed from chilling by a cover of straw or the surplus manure. The mushroom bed may be made as well in a cave, with the advantage of requiring less care, the atmospheric temperature being generally equable.

A mushroom bed may be kept fruitful or productive by sprinkling it with water in which mushrooms have been washed and skinned before cooking, also by treading some mushrooms under foot upon the bed occasionally so that the spores may absorb its fertility. Another method is to mix the parings of mushrooms with good horse droppings and scatter this in shrubberies or gardens upon a soil previously worked with the mattock or spade.

Treatises on horticulture, generally, commend the laborious and expensive methods practiced by the kitchen gardeners of Paris, but, says Dr. Roques—*

> A sure method I owe to nature's teaching revealed by accident. All rich earth which is charged with the droppings of our domesticated animals, especially of the bovine or ovine race, when half rotted and blanched by deprivation of air and sunlight, will produce an edible mushroom sooner or later. Market gardeners who have heaps of this fertilizer in reserve find mushrooms growing in it. If such half-rotted manure be placed in a dry cave or other dry and covered place it will spawn in a few weeks if not made too damp by injudicious watering. Gardeners who keep such a supply of rich mold on hand for a top-dressing for early onion, radish, and lettuce beds, etc., may thus obtain two crops for one, and gather their mushrooms without injury to the crop of other plants. The same results would follow if they should top-dress melon beds to the depth of 2 or 3 inches with this blanched manure. The crop thus obtained would well repay them, equally as well as the melon crop, without undervaluing the latter. I give this as my practical experience and not as gleaned from some book in a chimney corner.

It is said that Micheli sowed the spores of some gilled mushrooms on a heap of decomposing leaves of the scarlet oak and gathered a crop of mushrooms. The successful experiments of some later naturalists have repeated the experience of the Italian botanist. This goes to show a power of reproduction in the mushroom spore independent of the usual medium of rotted horse manure. Dr. Thore, in his "Flore des Landes," is authority for the statement that in that province the *Boletus edulis*

*Quoted by Dr. Barla in his work on the Edible Mushrooms of Nice and its Environs, published with illustrations in 1859.

and *Russula virescens*, two choice varieties, are propagated by pouring out upon the ground in a shrubbery planted with oaks the water in which these two varieties have been boiled. No other care is required than to protect the plantation against the trespasses of horses, pigs, and horned cattle, which eat these plants with avidity. The method is said to be unfailing.

MYCELIUM OR SPAWN OF MUSHROOMS.

Although in my report "Food Products—II: Eight Edible and Twelve Poisonous Mushrooms of the United States," I have endeavored to explain at some length the terms mushroom "spawn" and mushroom "bricks" in answer to the inquiries for simple and easily understood explanations of the propagation of mushrooms for food and profit, yet since we continue to receive such inquiries and for the benefit of those who may not have seen the antecedent paper, I have deemed it desirable to add briefly some additional information on this subject. The mycelium of mushrooms or the mushroom spawn is usually white, but is also found yellow, and even red. It is distinguished by some writers as nematoid, fibrous, hymenoid, scleroid or tuberculous, and malacoid. The nematoid mycelium is the most common. Creeping along on the surface of the earth, penetrating it to a greater or less depth, developing in manure among the débris of leaves or decayed branches, always protected from the light, it presently consists of very delicate filamentous cells more or less loosely interwoven, divided, anastomosing in every direction and often of considerable extent.

Its presence is sometimes difficult to detect without the use of the microscope, either on account of its delicacy or because it is being intermingled with the organic tissues in which it has developed.

Sometimes mycelium unites in bundles more or less thick and branched. This has been called the fibrous mycelium. Where the filaments intercross closely, are felted, and inclined to form a membrane, it is hymenoid mycelium. Where the filaments are so small and close that they form very compact bodies, constituting those solid irregular products called sclerotium, it is scleroid or tuberculous mycelium. With malacoid mycelium we have nothing to do in this paper. It is a soft, pulpy, fleshy mycelium.

Dr. Leveillé has thus defined mycelium: "Filaments at first simple, then more or less complicated, resulting from the vegetation of the spores and serving as a support and root to the mushroom."

Italian writers are familiar with a substance called mushroom "stone," found in Naples and the environs. The *Polyporus tuberaster* grows upon it. It is simply a mass, of greater or less size, composed of earth, small stones, and the remnants of vegetation, united by a white, byssoid, abundant mycelium. It has been by some authors regarded as a species of volcanic tufa of an argillaceous and calcareous nature, but is nothing more than mycelium in which successive generations of this species of *Polyporus* have developed.

Although heat and humidity influence all kinds of vegetation, yet heat seems to exert less and humidity a greater influence on mushrooms than on other plants. It is chiefly during the cool, moist, autumnal weather that the fleshy mushrooms flourish most vigorously in the United States, one of the most fruitful countries known for this class of esculents. Rain falls copiously here in many places, hence it is a reasonable deduction that, as moisture is a condition favorable to the developement of these plants, they will be plentiful.

FOUR EDIBLE SPECIES.

PLATE II.—*Agaricus melleus* Vahl. (Order *Agaricini.*)

Subgenus ARMILLARIA (little bracelet).—Veil partial, annular, hence the name from armilla, an armlet or bracelet, alluding to the ample persistent collar of the plant. Described by Bulliard as *Agaricus annularius*, by Decandolle as *A. annularis*, by Persoon as *A. polymyces.*

Cap fleshy, honey-colored or ocherous, striated on the margin, shaded with brown, darker towards the center, umbonate or umbilicate in full-grown specimens, tufted with dark-brown fugitive hairs. Color of the cap varies, depending upon climatic conditions and the character of the soil. Gills distant, ending in a decurrent tooth, pallid or dirty white, very often showing brown or rust-colored spots when old. Spores white and abundant. Stem elastic, scaly, 4 inches or more in length. Ring floccose. Diameter of cap from 2 to 5 inches. Manner of growth cæspitose, and, as with most of the *Armillarias*, generally parasitic on old stumps, although I found the group here figured growing on moist, sandy clay, on a roadside, in Hyndsboro Park, Md.

PLATE III.—*Agaricus deliciosus* Fr.

Subgenus LACTARIUS (milk-bearing).—Hence the name, from *lac*, milk, applied to the exudation from the gills, which in some of the species resembles cow's milk. *Deliciosus* refers to the agreeable flavor of the plant, which is one of the most remarkable of this group.

Cap fleshy, hemispherical, then convex, umbilicate in some adult specimens, funnel-shaped, marked in the adult plant with rings or zones of a ferruginous color. Color of the cap orange, varying in tint, growing paler and greenish when old or dried. Diameter from 2 to 6 inches. Gills decurrent, crowded, rather thick, sometimes slightly forked at the base, according to some French writers on mushrooms. Color of the gills pale orange, sometimes a saffron yellow, exuding when bruised a bright red or orange-colored liquid, hence often given the name, popularly, of the "orange-milk" mushroom. This liquid turns green on exposure to the atmosphere. Stem attenuated downward, smooth, and stuffed with a yellowish pith, then hollow, and finally brittle. Color about the same as the cap.

PLATE IV.—*Cantharellus cibarius* Fr.

This species is distinguished from an Agaric, which at first sight it resembles, by having veins instead of gills. It has been described by Linnæus as *Agaricus cantharellus*, by Bulliard under the same name, by Scopoli as *Merulius cantharellus.* Fries does not put it in the list of the *Agaricini*, while Berkeley classifies it under that order. The *chantarelle* takes its name from a Greek word signifying a cup or vase, referring to its shape and possibly also to its rich golden color. *Cibarius* refers to its esculent properties.

Cap a rich egg yellow, at first convex, later concave and turbinated. Margin sinuous-undulate, smooth, and more extended on one side than the other. Diameter

AGARICUS (ARMILLARIA) MELLEUS.

Group from Hynesboro Park, Md., U.S.

K. MAYO, del.

Sackett & Wilhelms Lithographing Co. New York

AGARICUS (LACTARIUS) DELICIOSUS.

1 General form. 2 Section. 3 Spores.

Sackett & Wilhelms Lithographing Co. New York

CANTHARELLUS CIBARIUS FR.

1, 2, 3, 4, Various stages of growth. 5 A section.
6 Spores 7 Spores and basidia.
From Hynesbury, Md., U.S.

Sackett & Wilhelms Lithographing Co. New York

FISTULINA HEPATICA.

1 Specimen, upper view. 2 Same, under view.
3 Specimen, upper view. 4 Same, under view.
5 Spores.

K. MAYO, del.

Sachett & Wilhelms Lithographing Co. New York

nearly 4 inches. Veins rather thick and wiry, markedly decurrent, usually bifurcated two or three times, and of the same color as the cap. Spores white. Stem stuffed, thicker above, tapering downward, and slightly curved at the base. Flesh white and firm, odor agreeable, flavor a little peppery. Found in the woods in groups in summer and in autumn.

PLATE V.—*Fistulina hepatica* Fr. (Order *Polyporei.*)

Fistulina refers to the form of its little tubes situated on the under surface of this mushroom, *hepatica* to its fancied resemblance when old to a piece of liver. It is also called beef's tongue, which it sometimes resembles, when young, in shape and color.

Cap of variable form, upper surface at first blood red, covered with papillæ, then red brown, and finally a very dark red. Flesh fibrous, juicy, and mottled. Flavor acid, odor agreeable. Tubes at first short, then elongated, having fringed orifices, color whitish, turning brown when bruised. Sometimes found of quite large size. One is mentioned as found in England weighing 30 pounds. Found in summer and autumn on oak and beech trees principally. In Italy its common name is said to be "oak tongue" or "chestnut tongue," and it is said to be equally good whether gathered from one or the other.

This mushroom is described by Schaeffer as *Boletus hepaticus;* Bulliard gives it as *Fistulina buglossoides.* Berkeley describes a "beautiful and interesting species, *A.* (*Pleurotus*) *subpalmatus* Fr.," as having the flesh mottled like that of *Fistulina hepatica,* and also gives the habitat of *Polyporus quercinus* as identical with the species represented in Pl. v. Figs. 1, 2, 3, and 4 of this plate represent the color and form of the upper and under surfaces of specimens collected near Falls Church, Va., where the species grows in profusion.

For most beautiful specimens of this and many other of our native mushrooms I am indebted to Mr. F. J. Braendle, Falls Church, Va.

STRUCTURAL FEATURES OF VARIOUS ORDERS OF MUSHROOMS.

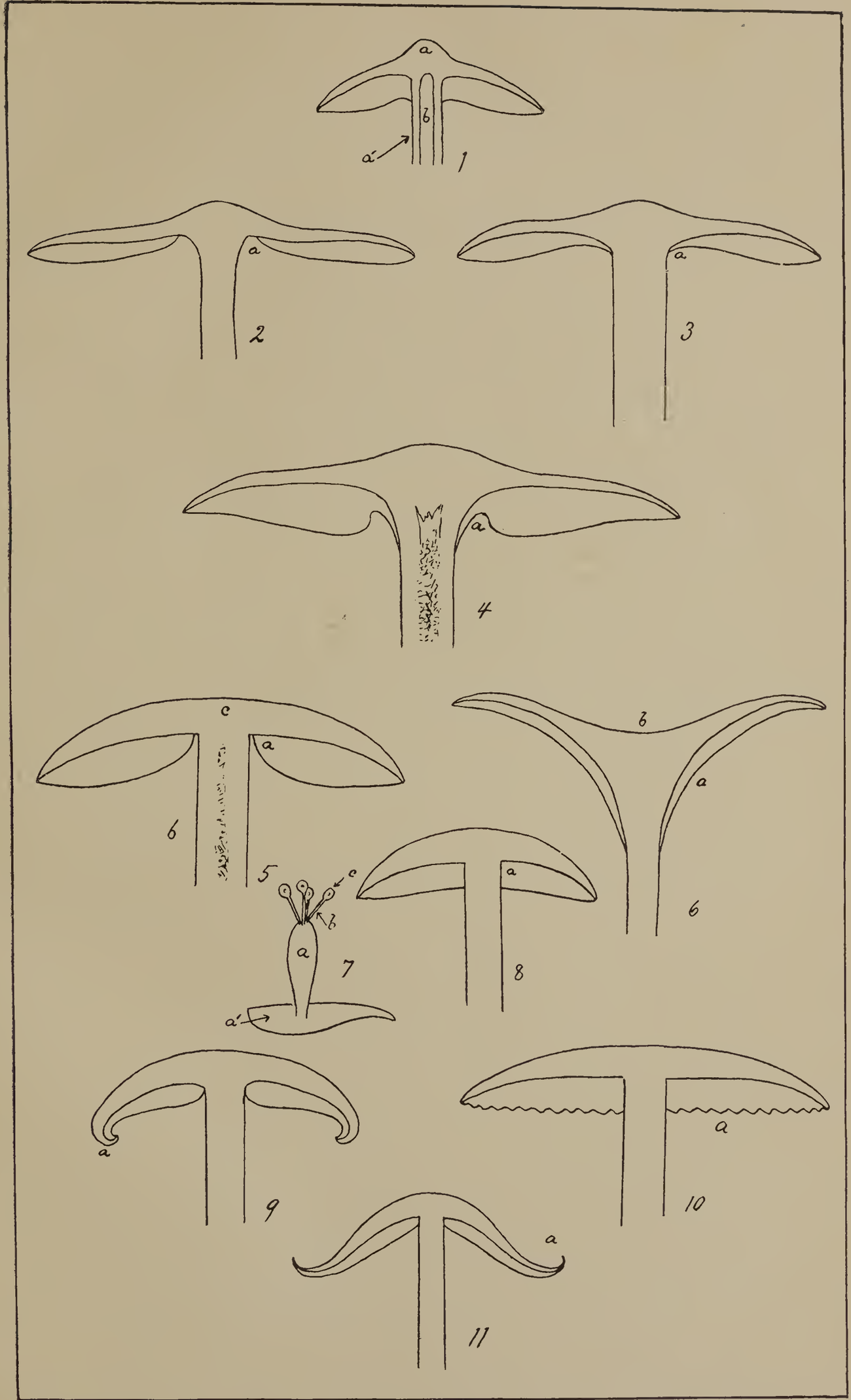
The structure of the gill-bearing mushrooms, or *Agaricini*, is shown in Plate VI, the description of which follows:

Fig. 1. Cap or pileus umbonate, *a*; stem or stipe fistulose, *b*; gills or lamellæ adnate and slightly emarginate.
Fig. 2. Gills remote, *i. e.*, distant from stem. (See *a*.)
Fig. 3. Gills adnexed, just reaching the stem, as at *a*, but not attached to it.
Fig. 4. Gills emarginate, with a tooth, as at *a*; stem stuffed.
Fig. 5. Cap obtuse, *c*; gills free, *i. e.*, just reaching the stem but not attached to it. (See *a*.) *b*, stem stuffed.
Fig. 6. Cap umbilicate, *b*; gills decurrent, *i. e.*, running down the stem. (See *a*.)
Fig. 7. Basidium cell, *a*, borne on the hymenium or spore-bearing surface of the gills; *b*, stigmata; *c*, spores.
Fig. 8. Gills adnate, *i. e.*, firmly attached to the stem at their inner extremity, as at *a*.
Fig. 9. Cap with border involute, *i. e*, rolled inward. (See *a*.)
Fig. 10. Lamellæ or gills dentated or toothed. (See *a*.)
Fig. 11. Cap with border revolute, *i. e.*, rolled backward. (See *a*.)

In the pore-bearing mushrooms, or *Polyporei*, the gills are replaced by tubes or pores. The tubes are little cylinders, long or short, pressed one against another, forming by their union a layer on the under surface of the cap and constituting the fructifying membrane in *Boleti*, the soft form of the order *Polyporei*. They also consist of the substance of the cap, and the sporiferous membrane or hymenium lines their inner walls. Their upper end is always closed, while the opposite extremity is open to permit the passage of the spores. The tubes are generally joined together, and may not be disunited unless they are torn apart. They are free in the sole genus *Fistulina*.

As regards their attachment to the cap they may be firmly adherent, as in Polyporus, or easily detached in a single mass, as in Boletus, the flesh of the latter being soft and tender. They frequently leave a circular space of greater or less dimensions around the stem or they adhere to or are prolonged upon it in such a manner that the orifices rise in tiers one above another. The color of the tubes, although not offering as characteristic varieties as that of the gills, changes nevertheless according to species and according to the age of the plant. The tubes may sometimes be of a different color from their orifices, as in *Boletus luridus*. In some Boleti the color of the flesh is changed on exposure to the air and the tubes often assume the same tints. The tubes generally called pores are sometimes closely adherent to the substance of the cap, which is commonly hard, corky, or coriaceous, as seen in most of the *Polyporei*.

The spines of the spine-bearing mushrooms, or *Hydnei*, are projecting conical elevations divided or entire, simple or ramified, having the appearance of points or spines, and are formed by the substance of the cap on the inner surface of which they are attached. The spines are



L. KRIEGER, DEL.

SECTIONS OF MUSHROOMS.

clothed with the sporiferous membrane (*hymenium*) and are the seat of the organs of fructification in mushrooms of the genus *Hydnum*. In the early stages of development they look like little projecting points or papillæ, those on the margin of the cap and at the apex of the stem being always less developed, frequently remaining in this rudimentary state. They are rounded in *Hydnum imbricatum*, sometimes compressed in *Hydnum repandum*, sometimes terminating in hairs, as in *Hydnum barba Jovis*, or they may be very much divided, as in *Hydnum fimbriatum*.

In the *Auricularini* the hymenium is more or less even.

In *Clavariei* the whole fungus is club-shaped or more or less intricately branched, with the hymenium covering the outer surface.

In the *Tremellini* we have a gelatinous substance and a great departure from the character of the substance, external appearance, and internal structure of the other orders in this family. The form is lobed, folded, convolute, often resembling the brain of some animal. It is uniformly composed throughout of a colorless mucilage with no appreciable texture, in which are distributed very fine, diversely branched, and anastomosing filaments. Towards the surface the ultimate branches of this filamentose network give birth to globular cells, both at their summits and laterally, which attain a comparatively large size. These cells are filled with a protoplasm, to which the plant owes its color. When they have obtained their normal dimensions they elongate at the summit into two, three, or four distinct, thick, obtuse tubes, into which the protoplasm gradually passes. The development of these tubes is by degrees; as each tube attains its full size it is attenuated into a fine point. Sometimes these tubes or spicules send out one or two lateral branches, each terminated by a spore. These spores are smooth and deposit themselves like a fine white dust on the surface of the Tremella and on its matrix.

GLOSSARY OF TERMS USED IN DESCRIBING MUSHROOMS.

Abortive, imperfectly developed.
Acaulescent, acaulous, having a very short stem or none.
Acetabuliform, cup-shaped.
Acicular, needle-shaped.
Aculeate, slender pointed.
Acuminate, terminating in a point.
Acute, sharp pointed.
Adnate, gills firmly attached to the stem.
Adnexed, gills just reaching the stem.
Adpressed, pressed in close contact, as applied to gills.
Æruginous, verdigris-green.
Agglutinated, glued to the surface.
Aggregated, collected together.
Alveolate, socketed or honey-combed.
Amphigenous, when the hymenium is not restricted to a particular surface.
Analogy, superficial or general resemblance without structural agreement.
Anastomosing, branching, joining of one vein with another.
Annular, ring-shaped.
Annulate, having a ring.
Annulus, ring round the stem of agarics.
Apex, in mushrooms the extremity of the stem nearest the gill.
Apical, close to the apex.
Apiculate, terminating in a small point.
Appendiculate, hanging in small fragments.
Approximate, of gills which approach the stem but do not reach it.
Arachnoid, cobweb-like.
Arboreal, arboricle, tree-inhabiting.
Arcuate, bow-shaped.
Areolate, divided into little areas or patches.
Argillaceous, clayey, like clay.
Ascending, directed upward.
Asci, ascidia, spore-cases of certain mushrooms.
Attenuated, tapering gradually to a point upward or downward.
Band, a broad bar of color.
Banded, marked with bands.
Barbed, furnished with fibrils or hairs.
Basidia, cellular processes of certain mushroom-bearing spores.
Bibliography, condensed history of the literature of a subject.
Bifurcated, divided into two, as in the gills of certain agarics.
Booted, applied to the stem of a mushroom when inclosed in a sheath or volva.
Boss, a knob or short rounded protuberance.
Bossed, bullate, furnished with a boss or knob.
Branched, dividing from the sides; also styled furcate and forked.
Brick, trade term for a mass of mushroom spawn, in dimensions the size of a brick of masonry.
Broad, wide or deep vertically.
Bulbous, having the structure of a bulb.
Cæspitose, growing in tufts.
Calcareous, chalky, chalk-like.
Calyptra, applied to the portion of volva covering the pileus.
Campanulate, bell-shaped.
Canaliculate, channeled.
Cancellate, latticed, marked both longitudinally and transversely.
Cap, the expanded, umbrella-like receptacle of the common mushroom.
Capillitium, spore-bearing threads, variable in thickness and color, sometimes continuous with the sterile base, sometimes free, dense, and persistent, or lax and evanescent, often branched; found in the Lycoperdons.
Carious, decayed.
Carneous, fleshy.
Cartilaginous, hard and tough.
Castaneous, chestnut color.
Ceraceous, wax-like.
Channeled, hollowed out like a gutter.
Chlorosis, loss of color.
Cilia, marginal hair-like processes.
Ciliate, fringed with hair-like processes.
Cinerous, ash-colored.

Circinate, rounded.

Clathrate, latticed.

Clavate, club-shaped, gradually thickened upward.

Close, packed closely side by side; also styled crowded.

Columella, a sterile tissue rising column-like in the midst of the capillitium, serving as a point of insertion for the threads which connect it with the peridium in the form of a net-work.

Concentric, having a common center, as a series of rings one within another.

Connate, united by growing, as when two or more caps become united.

Concolored, of a uniform color.

Confervoid, from the finely branched threads.

Continuous, without a break, of a surface which is not cracked, or of one part which runs into another without interruption.

Cordate, heart-shaped.

Coriaceous, of a leathery texture.

Corrugated, drawn into wrinkles or folds.

Corticated, furnished with a bark-like covering.

Cortina, a partial veil formed not of continuous tissue but of slender threads, which in certain mushrooms when young unite the stem with the margin of the cap. This membrane remains later as a filamentous ring on the stem, or threads hanging to the margin of cap. Applied to the peculiar veil of the Cortinarias.

Cratera, a cup-shaped receptacle.

Crenate, crenulate, notched at the edge, the notches blunt or rounded, not sharp as in a serrated edge, serratures convex.

Cribrose, pierced with holes.

Cryptogamia, applied to the division of nonflowering plants.

Cupreous, copper-colored.

Cuspidate, with a sharp, spear-like point.

Cyathiform, cup-shaped.

Cystidia, sterile cells of the hymenium, generally larger than the basidia cells, with which they are found.

Deciduous, temporary falling off.

Decurrent, as when the gills of a mushroom are prolonged down the stem.

Dehiscent, a closed organ opening of itself at maturity, or when it has attained a certain development.

Deliquescent, relating to mushrooms which at maturity become liquid.

Dentate, toothed, with concave serratures.

Denticulate, finely dentate.

Dermini, brown or rust-colored spores.

Determinate, ending definitely; having a distinctly defined outline.

Diaphanous, transparent.

Dichotomous, paired by twos; regularly forked.

Dimidiate, applied to some gills of mushrooms which reach only halfway to the stem.

Disciform, of a circular, flat form.

Dissepiments, dividing walls.

Distant, applied to gills which have a wide distance between them.

Divaricate, separating at an obtuse angle.

Echinate, furnished with stiff bristles.

Echinulate, with minute bristles.

Effused, spread over without regular form.

Elongate, lengthened.

Emarginate, applied to gills which are notched or scooped out suddenly before they reach the stem.

Embryo, the mushroom before leaving its volva or egg stage; also any early stage of mushrooms which may have no volva.

Entire, the edge quite devoid of serrature or notch.

Epidermis, the external or outer layer of the plant.

Epiphytal, growing upon another plant.

Equal, all gills of the same, or nearly the same length from back to front.

Eroded, the edge ragged, as if torn.

Etiolated, whitened, bleached.

Even, distinguished from smooth; a surface quite plane as contrasted with one which is striate, pitted, etc.

Excentric, out of center. The stems of some mushrooms are always excentric.

Exotic, foreign.

Family, a systematic group in scientific classification embracing a greater or less number of genera which agree in certain characters not shared by others of the same order.

Farinaceous, mealy.

Farinose, covered with a white, mealy powder.

Fascia, a band or bar.

Fasciate, zoned with bands.

Fasciculate, growing in small bundles.

Fastigiate, bundled together like a sheath.

Favose, honeycombed.
Ferruginous, rust-colored.
Fibrillose, clothed with small fibers.
Fibrous, composed of fibers.
Filiform, thread-like.
Fimbriated, fringed.
Fissile, capable of being split.
Fistular, fistulose, tubular.
Flabelliform, fan-shaped.
Flavescent, yellowish, or turning yellow.
Flexuose, wavy.
Flocci, threads as of mold.
Floccose, downy.
Flocculose, covered with flocci.
Foveolate, pitted.
Free, in relation to the gills of mushrooms reaching the stem but not attached to it.
Fringe, a lacerated marginal membrane.
Fructification, reproducing power of a plant.
Fugacious, disappearing rapidly.
Furcate, forked.
Fuliginous, blackish or sooty.
Fulvous, tawny; a rather indefinite brownish yellow.
Furfuraceous, with branny scales or scurf.
Fuscous, brownish, but dingy; not pure.
Fusiform, spindle-shaped.
Genera, plural of genus.
Generic, pertaining to a genus.
Genus, a group of species having one or more characteristics in common; the union of several genera presenting the same features constitutes a tribe.
Gibbous, in the form of a swelling; of a pileus which is more convex or tumid on one side than the other.
Gills, vertical plates radiating from the stem on the under surface of the mushroom cap.
Glabrous, smooth.
Glaucescent, inclining to glaucose.
Glaucose, covered with a whitish-green bloom or fine white powder easily rubbed off.
Globose, nearly spherical.
Granular, with roughened surface.
Greaved, of a stem clothed like a leg in armor.
Gregarious, of mushrooms not solitary but growing in numbers in the same locality.
Grumous, clotted; composed of little clustered grains.
Guttate, marked with tear-like spots.
Gyrose, circling in wavy folds.
Habitat, natural abode of a vegetable species.
Hepatic, pertaining to the liver; hence, liver-colored.
Heterogeneous, of a structure which is different from adjacent ones.
Hibernal, pertaining to winter.
Hirsute, hairy.
Homogeneous, similar in structure.
Hyaline, transparent.
Hygrophanous, looking watery when moist and opaque when dry.
Hymenium, the fructifying surface of the mushroom; the part on which the spores are borne.
Hymenophore, the structure which bears the hymenium.
Hypogæous, subterranean.
Identification, the determination of the species to which a given specimen belongs.
Identify, to determine the systematic name of a specimen.
Imbricate, overlapped like tiles.
Immarginate, without a distinct border.
Immersed, sunk into the matrix.
Incised, cut out; cut away.
Indehiscent, not opening.
Indigenous, native of a country.
Inferior, growing below; of the ring of an agaric, which is far down on the stem.
Infundibuliform, funnel-shaped.
Innate, adhering by growing into.
Inserted, growing like a graft from its stock.
Involute, edges rolled inward.
Laciniate, divided into flaps.
Lactescent, milk-bearing.
Lacunose, pitted or having cavities.
Lamellæ, gills of mushrooms.
Lanceolate, lance-shaped; tapering to both ends.
Lateral, attached to one side.
Latex, the viscid fluid contained in some mushrooms.
Laticiferous, applied to the tubes conveying latex, as in the Lactarias.
Lepidote, scurfy with minute scales.
Leucospore, white spore.
Ligneous, woody consistency.
Linear, narrow and straight.
Linguiform, tongue-shaped.

Maculate, spotted.

Marginate, having a distinct border.

Matrix, the substance upon which a mushroom grows.

Medial, at the middle; of the ring of a mushroom which is between superior or near the apex of the stem, and distant or far removed from the apex.

Merismoid, having a branched or laciniate pileus.

Moniliform, contracted at intervals in the length, like a string of beads.

Multifid, having many divisions.

Multipartite, divided into many parts.

Mycelium, the delicate threads proceeding from the germinating spores, usually white and popularly termed spawn.

Narrow, of very slight vertical width.

Netted, covered with projecting reticulated lines.

Nucleus, contents of spore.

Obconic, inversely conical.

Obcordate, like an inverted heart.

Oblique, slanting.

Oblong, longer than broad.

Obovate, inversely egg-shaped, broadest at the apex.

Obtuse, blunt or rounded.

Ochrospore, ocher-colored spore.

Orbicular, having the form of an orb.

Order, group of a classification intermediate between tribe and family.

Ostiole, ostiolum, mouth of the perithecium; orifice through which the spores are discharged.

Ovate, egg-shaped.

Pallid, pale, undecided color.

Papillate, papillose, covered with soft tubercles.

Paraphyses, sterile cells found with the reproductive cells of some plants.

Parasitic, growing on and deriving support from another plant.

Partial, of a veil clothing the stem and reaching to the edge of the cap but not extending beyond it.

Patent, spreading.

Pectinate, toothed like a comb.

Pedicel, foot-stock.

Pedicillate, having a pedicel.

Pelliculose, furnished with a pellicle or distinct skin.

Penciled, with pencil-like hairs either on the tip or border.

Peridium, general covering of a puff-ball, simple or double, dehiscent or indehiscent at maturity.

Perithecia, bottle-like receptacles containing asci.

Peronate, used when the stem has a distinct stocking-like coat.

Persistent, inclined to hold firm, tenacious.

Pervious, forming an open tube-like passage.

Pileate, having a cap.

Pileoli, secondary pilei; arising from a division of the primary pileus.

Pileus, the cap, receptacle, or one part of a mushroom; other parts are the stem and gills.

Pilose, covered with hairs.

Pits, depressions in cells or tubes resembling pores.

Plumose, feathery.

Pore, orifice of the tubes of polypores.

Poriform, in the form of pores.

Porous, having pores.

Powdery, covered with bloom or powder.

Projecting, the anterior end jutting out beyond the margin.

Proliferous, applied to an organ which gives rise to secondary ones of the same kind.

Pruinose, covered with frost-like bloom.

Pruniform, plum-shaped.

Pubescent, downy.

Pulverulent, covered with dust.

Pulvinate, cushion-shaped.

Punctate, dotted with points.

Pyriform, pear-shaped.

Quaternate, arranged in groups of four.

Receptacle, a part of the mushroom extremely varied in form, consistency, and size, inclosing the organs of reproduction.

Remote, when the margin of the gill comes to an end before reaching the stem.

Reniform, kidney-shaped.

Repand, bent backwards.

Resupinate, of mushrooms spread over the matrix without any stem and with the hymenium upwards; inverted by twisting of the stalk.

Reticulate, marked with cross lines like the meshes of a net.

Revolute, rolled backwards; of the margin of a cap; the opposite of involute.

Rhodospore, rose or pink spore.

Rimose, cracked.

Ring, a part of the veil adhering to the stem of a mushroom in the shape of a ring.

Rivulose, marked with lines like rivulets.

Rubiginous, rust colored.

Rufescent, reddish in color.

Rugose, wrinkled.

Scabrous, rough on the surface, scaly.

Scarious, shriveled.

Scissile, of two plates lying together but capable of being separated.

Sclerotoid, hard; a form assumed by the mycelium of certain mushrooms.

Scrobiculate, marked with little pits or depressions.

Separating, becoming detached, as gills from the stem or of gills from their matrix.

Serrate, saw-toothed; indented like a saw.

Sessile, seated without a stalk.

Simple, not branched, divided or connected together.

Sinuate, of a cap with a wavy margin, or of gills where they have a sudden wave or sinus where they reach the stem.

Spathulate or *Spatulate,* spatula-shaped, or spoon-shaped.

Spawn, the popular name for mycelium used in the propagation of mushrooms; that from which the perfect fungus arises, reproducing the parent form.

Species, an organic body, animal or vegetable, having its peculiar characteristics which differ from the bodies belonging to the same genus.

Spheroidal, partaking of the shape of a sphere.

Spores, the reproductive bodies of cryptogams; analogous to seeds. The spore in germinating gives birth to the mycelium.

Sporida, name given by some mycologists to reproductive spores of the mother cell.

Sporophore, name given by some naturalists to the basidia.

Squamose, having scales.

Squamulose, covered with small scales.

Squarrose, rough, with projecting or deflexed scales.

Stoloniferous, applied to a trailing and rooting branch.

Stellate, star-shaped.

Stem, the ascending axis of plants.

Stigmata, applied to the fructification of the hymenomycetes; the slender and delicate supports of the spores on the basidium cell.

Stipe, name applied to the stem of mushrooms.

Stipitate, having a stem.

Straight, the edge plane and even.

Striate, streaked with longitudinal lines.

Strigose, covered with sharp, rigid lines in the form of channels.

Strobiliform, pineapple shape.

Stuffed, of a stem filled with substance of a different texture from its walls.

Sub, commonly employed as a diminutive.

Subiculum, the thready mycelium forming the under layer of the mushroom.

Subulate, awl-shaped; narrowing and tapering from base to apex.

Sulcate, furrowed.

Superior, the upper surface; applied to the ring when near the apex of the stem.

Theca, cell-mother, the protoplasm of which originates by segmentation; a certain number of spores, usually eight, held in suspension in the protoplasm of the theca without being attached to each other or to the cell walls.

Thecaspore, the spore thus encased.

Tomentose, downy, with short hairs.

Torsive, spirally twisted.

Torulose, a cylindrical body swollen and restricted alternately.

Toxic, poisonous.

Trama, the substance proceeding from the hymenophore, intermediate between the plates (central in) of the gills of agarics.

Transverse, crosswise.

Tremelloid, jelly-like.

Truncate, ending abruptly, as if cut short; cut squarely off.

Tubæform, trumpet-shaped.

Tubercle, a small wart-like excrescence.

Tubular, hollow and cylindrical.

Turbinate, top-shaped.

Typical, agreeing closely with the characters assigned to a group or species.

Umbilicate, having a central depression.

Umbo, the boss of a shield; applied to the central elevation of the cap of some mushrooms.

Umbonate, having a central boss-like elevation.

Uncinate, hooked.

Unequal, short imperfect gills interspersed among the others.

Universal, used in relation to the veil or volva which entirely envelops the mushroom when young.

Variety, an individual of a species differing from the rest in external form, size, color, and other secondary features, without perpetuating these differences only under exceptional circumstances.

Veil, in mushrooms a partial covering of the stem or margin of the pileus.

Veliform, a thin veil-like covering.

Venate, Veined, intersected by swollen wrinkles below and on the sides.

Ventricose, swollen in the middle.

Vernicose, shining as if varnished.

Verrucæ, warts or glandular elevations.

Verrucose, covered with warts.

Villose, villous, covered with long, weak hairs.

Virescent, greenish.

Virgate, streaked.

Viscid, covered with a shiny liquid which adheres to the fingers when touched.

Viscous, gluey.

Volute, rolled up in any direction.

Volva, a substance covering the mushroom, sometimes membranous, sometimes gelatinous; the universal veil.

Walnut brown, a deep brown like that of some varieties of wood. (Raw umber, and burnt sienna and white.)

Wart, an excrescence found on the cap of some mushrooms; the remains of the volva in form of irregular or polygonal excrescences, more or less adherent, numerous, and persistent.

Zone, a broad band encircling a mushroom.

Zoned, furnished with one or more concentric circles.